TEACHING PLAN: MECHANICAL VIBRATION M.TECH 2ND SEM.

SCHOOL OF ENGINEERING AND TECHNOLOGY		**ACADEMIC SESSION: 2022-23**	**FOR STUDENTS' BATCH:2022-2024**	
1	**Course code**	**MMED-203**		
2	**Course Title**	**Vibration Analysis**		
3	**Credits**	**4**		
4	**Learning Hours**	**Contact Hours: 3** **Practical Teaching: 0** **Project, Tutorial, and Assessment: 1** **Total hours: 4**		
5	**Course Objective**	1. To present a working knowledge of vibrations and enabling the students to analyze vibrating systems ranging from single degree of freedom system to multi degrees of freedom systems such as spring mass system to vibrations in advanced systems such as internal combustion engines and continuous systems. 2. To teach students how to use the theoretical principles of vibration and vibration analysis techniques for the practical solution of vibration problems. 3. To enable the student to fully understand the importance of vibrations in mechanical design of machine parts that operate in vibratory conditions. 4. To present students with theoretical background and engineering applications of vibration problems. 5. To teach students the importance of nonlinear, random and transient vibrations in the design of vibration problems.		
6	**Course Outcomes**	CO1: Obtain equations of motion to understand the behaviour of oscillatory systems. CO2: Understand the fundamentals of various damping systems to reduce vibration. CO3: Learn various vibration excitations, practical aspects of isolations, and vibration measuring instruments. CO4: Analyse the mathematical modelling of the two degrees of freedom systems and various vibration-absorbing devices. CO5: Understand the characteristics of noise, sound, and its relationship with power and intensity.		
7	**Outline syllabus:** Introduction,Single degree of freedom (SDOF) systems, Free vibrations of SDOF systems, Harmonic excitation of SDOF systems, Two degree-of-freedom systems, Noise, Sound level, and subjective response to sound.			
7.01	**Paper Code**	**Unit**	**Introduction**	**Reference number**	**Teaching methods**
	MMED-203	(I)	**System with single degree of freedom:** Review of free and forced vibration with or without damping, transmissibility. **System with more than one degree**	Singiresu, S. R. (1995). *Mechanical vibrations*. Boston, MA: Addison Wesley.	Whiteboard, PPT slides, Tutorials, Demonstration

			of freedom: Systems with two degree of freedom, undamped vibration absorbers, generalized co-ordinates and coordinates coupling, orthogonally of natural modes. **Self Learning Topics:** Knowledge of principles of undamped, damped and forced vibrations	Page no:29-152	
		(II)	**Vibration Control:** Vibration isolation and motion isolation for harmonic excitation, practical aspects of vibrationanalysis, shock isolation, Dynamic vibration absorbers, Vibration dampers. **Vibration Measurement and Applications:** Introduction, Transducers, Vibration pickups, Frequency measuringinstruments, Vibration exciters, Signal analysis.	Singiresu, S. R. (1995). Mechanical vibrations. Boston, MA: Addison Wesley. Page no:153-296	Whiteboard, PPT slides, Tutorials, Demonstration
		(III)	**Continuous Systems:** Transverse vibration of string, longitudinal and torsional vibrations of rods, Euler equationsfor beams. **Modal analysis and Condition Monitoring:** Dynamic Testing of machines and Structures, Experimental Modalanalysis, Machine Condition monitoring and diagnosis.	Singiresu, S. R. (1995). Mechanical vibrations. Boston, MA: Addison Wesley. Page no:297-402	Whiteboard, PPT slides, Tutorials, Demonstration
		(IV)	**Transient Vibration of single Degree-of freedom systems:** Impulse excitation, arbitrary excitation, Laplace transforms formulation, Pulse excitation and rise time, Shock response spectrum, Shock isolation. **Introduction to Random vibration**: Mathematical descriptions of stochastic Process, stationary and ergodicity, Gaussian random process, correlation function and power spectral density, Introduction to diagnostic maintenance and signature analysis.	Singiresu, S. R. (1995). Mechanical vibrations. Boston, MA: Addison Wesley. Page no:509-595	Whiteboard, PPT slides, Tutorials, Demonstration
		(V)	**Non-Linear Vibrations**: Non Linear Vibrations: Introduction, Sources of nonlinearity, Qualitative analysis of nonlinear systems. Phase plane,	1.https://www.me.psu.edu/lamancusa/me458/3_human.pdf	Whiteboard, PPT slides, Tutorials, Demonstrati

			Conservative systems, Stability of equilibrium, Method of isoclines, Perturbation method, Method of iteration, Self-excited oscillations.	2.https://www.mne.psu.edu/lamancusa/me458/4_metrics.pdf	on

8	**Course Evaluation**	
8.10	**CA: 20%**	
8.1	**Attendance**	10%
8.12	**Homework**	10%
8.13	**Quizzes**	-
8.14	**Projects**	-
8.15	**Presentation**	-
8.16	**Any other**	-
8.2	**MTE(IA)**	20%
8.3	**End-term examination: 60%**	
9	**Text Books & References**	
9.1	**Text books**	1. S. Graham Kelly: Mechanical Vibrations: Theory and Applications 2. Den Hartog, J. P.: Mechanical Vibrations 3. Rao, S. S.: Mechanical Vibrations 4. J. S. Rao, Dr. K. Gupta: Introductory Course on Theory and Practice ofMechanical Vibrations 5. Mechanical Vibrations: G.K.Grover
9.2	**References**	1. Rosenhouse G. BASIC PRINCIPLES. In: Braun S, editor. Encyclopedia ofVibration [Internet]. Oxford: Elsevier; 2001. p. 124–37. Available from:https://www.sciencedirect.com/science/article/pii/B0122270851000886 2. Norton MP, Drew SJ. VIBRATION GENERATED SOUND | Fundamentals. In: Braun S, editor. Encyclopedia of Vibration [Internet]. Oxford: Elsevier; 2001. p. 1443–55. Available from: https://www.sciencedirect.com/science/article/pii/B0122270851002071 3. Singh R. Chapter 6 - Ultrasonic Testing. In: Singh R, editor. Applied Welding Engineering (Second Edition) [Internet]. Second Edition. Butterworth-Heinemann; 2016. p. 343–55. Available from: https://www.sciencedirect.com/science/article/pii/B9780128041765000268 4.Bein T, Bös J, Mayer D, Melz T. 10 - Advanced materials and technologies for reducing noise, vibration and harshness (NVH) in automobiles. In: Rowe J, editor. Advanced Materials in Automotive Engineering [Internet]. Woodhead Publishing; 2012. p. 254–98. Available from: https://www.sciencedirect.com/science/article/pii/B9781845695613500107
9.3	**Video References**	1. https://nptel.ac.in/courses/112107212 2. https://nptel.ac.in/courses/112103112

Mapping of Outcomes v. Topics

Course Outcome	Program Outcome												PSO			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1	3	3	2	3	1	2	1		2	2	1	2	3	3	2	2
CO2	3	3	3	3	2	2	1		1	1	1	1	3	3	2	2
CO3	3	3	3	3	3	2	2		2	2	2	2	3	3	2	2
CO4	3	3	3	3	3	2	2		2	1	1	1	3	2	2	1
CO5	3	2	1	1	3	3	2		1	1	1	2	3	2	3	2

QUESTION BANK

1. Give two examples each of the bad and the good effects of vibration.

2. Define Single degree of freedom.

3. Classify vibration.

4. Define damped vibration.

5. What is deterministic vibration.

6. Write the procedure of vibration analysis.

7. Define Viscous Damping.

8. Define Dry-Friction Damping.

9. Define Hysteretic Damping.

10. Define these terms: cycle.

11. Define these terms: amplitude.

12. Define these terms: phase angle.

13. Define these terms: linear frequency.

14. Define these terms: period.

15. Define these terms: natural frequency.

16. What are the three elementary parts of a vibrating system?

17. Define the number of degrees of freedom of a vibrating system.

18. What is the difference between a discrete and a continuous system? Is it possible to solve?

any vibration problem as a discrete one?

19. In vibration analysis, can damping always be disregarded?

20. Can a nonlinear vibration problem be identified by looking at its governing differential equation?

21. What is the difference between deterministic and random vibration? Give two practicals'

examples of each.

22. What methods are available for solving the governing equations in the vibration problem?

23. How do you connect several springs to increase the overall stiffness?

24. Define spring stiffness and damping constant.

25. What are the common types of damping?

26. State three different ways of expressing a periodic function in terms of its harmonics.

27. How can we obtain the frequency, phase, and amplitude of a harmonic motion from the corresponding rotating vector?

28. How do you add two harmonic motions having different frequencies?

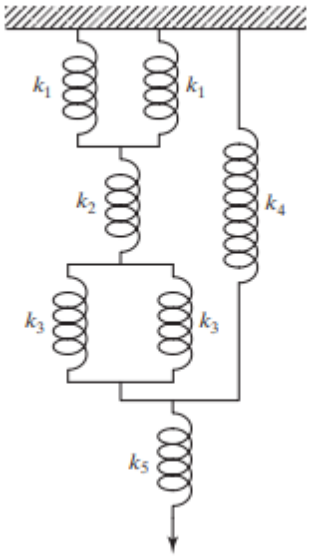
29. What are beats?

30. Define the terms decibel and octave.

31. Explain Gibbs phenomenon.

32. What are half-range expansions?

33. Determine the equivalent spring constant of the system shown in Fig. below



34. Consider two nonlinear dampers with the same force-velocity relationship given by $F = 1000v + 400v^2 + 20v$ with F in newtons and v in meters/second. Find the linearized damping constant of the dampers at an operating velocity of 10 m/s.

35. If the linearized dampers of $F = 1000v + 400v^2 + 20v$ are connected in parallel, determine the resulting equivalent damping constant.

36. What is the equivalent stiffness of a spring?

37. Derive Newton's second equation of motion?

38. Define Momentum.

39. State D-Alembert's Principle.

40. State the Principle of Virtual Displacements.

41. State Equation of Motion of a Spring-Mass System in Vertical Position.

42. Define torsional vibration.

43. Write the application of shock observer in bike.

44. Suggest a method for determining the damping constant of a highly damped vibrating system that uses viscous damping.

45. State the parameters corresponding to m, c, k, and x for a torsional system.

46. What effect does a decrease in mass have on the frequency of a system?

47. What effect does a decrease in the stiffness of the system have on the natural period

Graphical representation of the motion of a harmonic oscillator.

48. A helical spring, when fixed at one end and loaded at the other, requires a force of 100 N to produce an elongation of 10 mm. The ends of the spring are now rigidly fixed, one end vertically above the other, and a mass of 10 kg is attached at the middle point of its length. Determine the time taken to complete one vibration cycle when the mass is set vibrating in the vertical direction.

49. An air-conditioning chiller unit weighing 2,000 lb is to be supported by four air springs. Design the air springs such that the natural frequency of vibration of the unit lies between 5 rad/s and 10 rad/s.

50. The maximum velocity attained by the mass of a simple harmonic oscillator is 10 cm/s, and the period of oscillation is 2 s. If the mass is released with an initial displacement of 2 cm,

find (a) the amplitude, (b) the initial velocity, (c) the maximum acceleration, and (d) the phase angle.

51. Name some sources of industrial vibration.

52. What are the various methods available for vibration control?

53. What is single-plane balancing?

54. Describe the two-plane balancing procedure.

55. What is whirling?

56. What is the difference between stationary damping and rotary damping?

57. How is the critical speed of a shaft determined?

58. What causes instability in a rotor system?

59. What considerations are to be taken into account for the balancing of a reciprocating engine?

60. What is the function of a vibration isolator?